PATENT
3672-0111P

IN THE U.S. PATENT AND TRADEMARK OFFICE

In re application of:		Before the Board of Appeals	
Thomas JACKSON et al.		Appeal No.:	
Appl. No.:	09/763,948	Group:	1637
Filed:	June 8, 2001	Examiner:	J. Fredman
Conf.:	3940		
For:	A MEANS FOR ELECTRICAL CONTACTING OR ISOLATION OF ORGANIC OR INORGANIC SEMICONDUCTOR AND A METHOD FOR ITS FABRICATION		

APPEAL BRIEF UNDER 37 C.F.R. §41.37

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P.O. Box 1450
Alexandria, VA 22313-1450

November 23, 2004

Sir:

The present brief for the Appellant is submitted pursuant to 37 C.F.R. §41.37.

(i) Real Party in Interest

The real party in interest in the present application is Penn State Research Foundation, University Park, Pennsylvania, as evidenced by the assignment recorded at Reel/Frame 013305/0477.

(ii) Related Appeals and Interferences

There are no related appeals or interferences.

(iii) Status of Claims

Claims 1-25 are pending in the application. Claims 9, 21 and 25 are objected to but have not been rejected. Thus, claims 1-8, 10-20, and 22-24 stand on appeal.

(iv) Status of Amendments

No amendments to the claims were made in response to the final rejection of claims 1-8, 10-20, and 22-24 issued on March 23, 2004. Responses containing only remarks were filed on June 23, 2004; August 17, 2004 and September 23, 2004. These responses were all entered by the Examiner.

(v) Summary of the Claimed Subject Matter

The present invention, as most broadly encompassed by the claims on Appeal, is drawn to a device for electrical contacting or for the isolation of organic or inorganic semiconductors in electronic or optoelectric devices which has a substrate, either in the form of

a) a contact material consisting of an organic or inorganic electrical conductor, or

b) an isolating material consisting of an organic or inorganic dielectric (see page 1, lines 9-14 of the specification); and

a patterned or unpatterned charge transfer material which is on or at a surface of the substrate (see page 2, lines 23-25 of the specification). The charge transfer material further forms a charge transfer complex with an organic or inorganic semiconductor and

a) comprises charge transfer components in the form of donors or acceptors,

b) forms a self-assembling layer of one or more atomic and/or molecular layers,

c) has a direct or indirect bond to the surface of the substrate, and

d) forms a donor material in the charge transfer complex if the semiconductor is an acceptor or forms an acceptor material in the charge transfer complex if the semiconductor is a donor material (see page 2, lines 26-34).

The device of the present invention has the property of improved contacts for contacting organic and inorganic semiconductors in electronic devices. The device of the present invention also has the properties of isolation of organic or inorganic semiconductors in electronic and

optoelectronic devices, particularly selective isolation to reduce and eliminate leakage current in an electronic semiconductor layer outside the effective area in the device or to reduce the effective channel length in organic or inorganic field effect transistors.

(vi) <u>Grounds of Rejection to be Reviewed on Appeal</u>

The only ground of rejection for appeal is whether Sato, U.S. Pat. No. 4,987,023 (hereinafter "Sato") discloses a device of the present invention, so as to anticipate the claims on Appeal.

(vii) <u>Arguments</u>

As noted above, the sole ground of rejection for review is whether Sato discloses a device of the claims on appeal. The Examiner asserts that the device of Sato meets the structural features of the claims. In this regard, one issue of dispute between the Appellants and the Examiner is whether the device of Sato is a "semiconductor" device. In an effort to clarify the record, Appellants will first briefly address this issue and then address the rejection in more depth.

As noted, the Examiner asserts that the semiconductor property of the instant claims does not distinguish the presently claimed invention from Sato because the device of Sato is or can be a semiconductor as well. See the Advisory Action of October 15, 2004. Appellants would like to clarify an argument presented in the response of September 23, 2004, and addressed by the Examiner in the Advisory Action of October 15, 2004. The Examiner's statement that "Applicant's reply concedes the point at issue, by agreeing that the compound of Sato can function as a semiconductor" (Advisory Action of October 15, 2004) indicates a misunderstanding or a mischaracterization of Appellant's position. Appellants stated on page 4 of the response of September 23, 2004 that,

> Thus, TCNQ, has the potential to have semiconducting properties under certain circumstances. However, TCNQ is not a semiconductor in Sato because it is not functioning as such in the device of Sato.

By analogy that is like saying that wood can be made into a door or a chair. However, even though both a door and a chair are wooden objects, one would never consider a door to be a chair. Similarly, while TCNQ can be used in a semiconductor, it does not mean that the device of Sato is a semiconductor. The rejection is addressed in depth with the following comments.

As noted above, the present invention may be most broadly summarized as being drawn to a device for electrical contacting or for the isolation of organic or inorganic semiconductors in electronic or optoelectric devices which has a substrate, either in the form of

a) a contact material consisting of an organic or inorganic electrical conductor, or

b) an isolating material consisting of an organic or inorganic dielectric(see page 1, lines 9-14 of the specification); and

a patterned or unpatterned charge transfer material which is on or at a surface of the substrate (see page 2, lines 23-25 of the specification). The charge transfer material further forms a charge transfer complex with an organic or inorganic semiconductor and

a) comprises charge transfer components in the form of donors or acceptors,

b) forms a self-assembling layer of one or more atomic and/or molecular layers,

c) has a direct or indirect bond to the surface of the substrate, and

d) forms a donor material in the charge transfer complex if the semiconductor is an acceptor or forms an acceptor material in the charge transfer complex if the

semiconductor is a donor material (see page 2, lines 26-34).

The device of the present invention has the properties of improved contacts for contacting organic and inorganic semiconductors in electronic devices; and improved isolation of organic or inorganic semiconductors in electronic and optoelectronic devices, particularly selective isolation to reduce and eliminate leakage current in an electronic semiconductor layer outside the effective area in the device or to reduce the effective channel length in organic or inorganic field effect transistors.

Teachings of Sato

As discussed by the Examiner in at lease the Office Action of March 23, 2004, Sato teaches a device having a substrate of an inorganic dielectric. The device of Sato is typified in Figure 1 of the reference, which depicts a display device having a transparent electrode (2) provided on a glass substrate (1). The electrode (2) has a first organic thin film (3), which contains acceptor molecules and a second organic thin film (4), which contains donor molecules, wherein (3) and (4) are alternately formed to produce a laminate. Finally a gold electrode (5) is provided on top of the laminate of (3) and (4). The

acceptor and donor molecular films (3) and (4), are based on molecules having tetracyanoquinodimethane (TCNQ) and tetrathiafulvalene (TTF), respectively.

Previous to Sato it had been proposed in the field, to use TCNQ and TTF as acceptors and donors; however it turned out to be very difficult to synthesize the molecules and orient them in a suitable state. This difficulty was overcome by preparing donor and acceptor molecules in separate solutions and using a Langmuir-Blodgett process to form a laminate film by stacking the different monomolecular films. Using the Langmuir-Blodgett process, it was possible to create alternating acceptor and donor molecular films having excellent performance in controlling the charge transfer between donor molecules and acceptor molecules created with external energy such as voltage or light radiation.

However, the energy input needed to obtain a normal operation with the above-described set-up was unacceptably large. The object of Sato was to address these problems and to provide an organic thin film having a small threshold value of an external potential and having an operative performance that only requires a small external energy. The device of Sato is made of a stack of organic thin-films of alternating acceptor and donor molecules. In

Sato, the second organic thin-film has a dipole moment PI with a center produced by charge transfer between the acceptor and donor molecules. In addition, at least one of the first and second organic thin-films includes a chemical species with the dipole moment P2, with the center such that dipole moment vectors are produced by a charge transfer between the acceptor or donor molecules that satisfy a certain formula. The chemical species in Sato having the dipole moment P2 has a conjugated hydrocarbon skeleton linked to a donor having an electron-attracting substituent of a nitro, cyano, carbonyl or sulphonyl group, and a donor molecule having an electron-donating substituent of an amino, alkoxy, or hydroxy group.

It is seen from an overall reading of Sato and, for example, in the embodiments of column 2, that the device of Sato is very different from that of the present invention. Sato discloses an organic thin-film device containing donor and acceptor molecules, such that the application of an external energy in the form of an electric field, voltage, or light results in charge transfer between at least a part of the donor/acceptor molecules inside the organic thin film. This charge transfer causes a change in absorption spectra or conductivity of the film creating a dipole moment in the film and hence functional devices such as

display devices, rectifiers, switching devices etc. may be created.

Sato teaches a passive organic thin-film device with alternating organic thin films with acceptor and donor molecules and at least one thin film containing a chemical species with a dipole moment given by some chemical species, such that the dipole moment produced by charge transfer between acceptor or donor molecules satisfies a formula that gives a special positional relationship between dipole moments PI and P2. These properties of Sato are necessary for the device of the reference to function as a passive display device.

In other words, the Examiner's assertion that Sato teaches a charge transfer material, specifically a charge transfer complex with an organic semiconductor is not correct. Sato fails to disclose an active semiconductor as with the present invention, and the device of Sato is not capable of functioning in active semiconductor devices, e.g. a field-effect transistor or a light-emitting diode.

Differences between the device of Sato and the invention

Briefly, Sato discloses only a passive device having alternating laminated and stacked layers of acceptor and donor molecules and having a chemical species to obtain a

voltage controlled dipole moment, thereby being able to provide a purely passive color display device. The device according to Sato does not comprise an active semiconductor.

As noted above, the Examiner has misinterpreted Appellants' statements that some of the materials used in Sato can be used in semiconductor devices to mean that the device of Sato can function as a semiconductor. However, that was not the intent of Appellants' arguments. As noted above, because a material may be manufactured into different products, does not mean that the end products are the same. Because wood may be made into a chair or a door does not mean that chair and a door are the same or that they may function interchangeably.

In the Advisory Action of September 3, 2004, the Examiner maintains the rejection with the assertion that Appellants' arguments that Sato fails to disclose the feature of a semiconductor is insufficient because "a semiconductor is a material that conducts more than an insulator but less than a conductor." The Examiner further states that, "the term is relative and has no specific value" and that the materials of Sato are "semiconductors."

Thus, the Examiner very briefly has stated that any of the compounds of Sato may be semiconductors depending upon

what is deemed to be the insulator at issue and the conductor at issue. The Examiner then states that the term semiconductor is relative and has no specific value. However, this last assertion regarding the meaning of "semiconductor" is incorrect and a gross oversimplification of semiconductor devices.

"Semiconductor" has a well-accepted meaning in the electronics field. Every solid material or element (or compound of elements) has its own characteristic energy band structure. The variation in the band structure is responsible for the variation of the electrical characteristics that are observed with the various materials. To understand the mechanism of current flow in solids, the electrons, which are set into movement, by an applied electric field, must be able to move into new energy states. This implies that there must be empty energy states available to the electrons. For instance, if a few electrons reside in an otherwise empty energy band, a large number of unoccupied states are available into which the electrons can move. The lower energy band is called the valence band and the upper energy band is called the conduction band and these are separated by a gap.

With an "insulator", the lowest energy band or valence band is filled and separated from the conducting band by

the band gap, thus containing no allowed energy states. At absolute zero (0°K) a semiconductor material behaves exactly like an insulator. However, the difference between a semiconductor material and an insulator is that the size of band gap is much smaller in the semiconductor than in an insulator. Thus, the electrons in semiconductors may be excited from the valance band to the conduction band by a relatively small input amount of thermal and optical energy. As a result, at room temperature a semiconductor with a small band gap will have a significant number of electrons that are excited thermally across the gap into the conduction band, but the insulators having a large band gap will remain insulating at room temperature. The difference between a material that may act as a semiconductor and materials that typically act as insulators is that the number of electrons for conduction can be significantly increased in the semiconductor material by thermal or optical energy.

In metals, the energy bands either overlap or are only partially filled. Electrons and empty energy states are intermixed within the bands so the electrons can move freely under the influence of the applied electric field and metals thus have a high electrical conductivity.

While the Examiner is correct that a semiconducting material does have the ability to conduct less than strong conductors but more than strong insulators, a "semiconductor" in addition to having the ability to function in a particular way, must also actually function in a particular manner to be defined as a "semiconductor." There is no such functional component in Sato. For example, tetracyanoquinodimethan (TCNQ), which is disclosed in Sato, can change from very low conductivity to very high conductivity under the influence of particular electromagnetic, thermal, or external electric fields. Thus, TCNQ, has the potential to have semiconducting properties under certain circumstances. However, TCNQ is not a semiconductor in Sato because it not functioning as such in the device of Sato. According to Sato, alternating layers of acceptor and donor materials are stacked between electrodes and the application of external energy such as an electric field and/or light results in a charge transfer between at least some of the donor and acceptor molecules inside the organic thin film.

As stated in Sato at col. 2, lines 30-35, "this charge transfer causes a change in absorption spectra or conductivity of the film to bring about positive and negative polarities in the film, thereby providing

functional devices such as display devices, rectifiers, switching devices or light-memory devices". Thus, Sato does not have a semiconductor.

In the present invention, however, a charge transfer material, which either may be a donor or an acceptor, is used for making the charge injection in the active semiconductor of the device more efficient. Whether the charge transfer material is a donor or acceptor, it forms a charge transfer complex with a semiconductor, which itself is either an acceptor or donor. In other words, to form the charge transfer complex for injecting current, the charge transfer materials must be either a donor or acceptor and the semiconductor must be the opposite. If a charge transfer material with donors is provided adjacent to a semiconductor material which also is a donor, the result will be an efficient insulation. In other words, combinations or charge transfer materials according to the present invention may form a charge transfer complex for the purpose of either injecting current into the active semiconductor of the semiconductor device or alternatively it may be used to isolate the active semiconductor electrically.

In summary, Sato discloses a passive device having alternating laminated and stacked layers of acceptor and

donor molecules and having a chemical species to obtain a voltage controlled dipole moment, thereby being able to provide a purely passive color display device. The device according to Sato does not comprise an active semiconductor, a required feature of the present invention. As such, the present invention is not anticipated by the reference and withdrawal thereof is respectfully requested.

The required Appeal Brief fee is attached hereto.

If necessary, the Commissioner is hereby authorized in this, concurrent, and future replies, to charge payment or credit any overpayment to Deposit Account No. 02-2448 for any additional fees required under 37 C.F.R. §§ 1.16 or 1.17; particularly, extension of time fees.

Respectfully submitted,

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(viii) Claims Appendix

1. A device for electrical contacting or for the isolation of organic or inorganic semiconductors in electronic or optoelectric devices comprising

a substrate, either in the form of

a) a contact material consisting of an organic or inorganic electrical conductor, or

b) an isolating material consisting of an organic or inorganic dielectric; and

a patterned or unpatterned charge transfer material, which is on or at a surface of the substrate and which forms a charge transfer complex with an organic or inorganic semiconductor,

wherein the charge transfer material

a) comprises charge transfer components in the form of donors or acceptors,

b) forms a self-assembling layer of one or more atomic and/or molecular layers,

c) has a direct or indirect bond to the surface of the substrate, and

d) forms a donor material in the charge transfer complex if the semiconductor is an acceptor or forms an acceptor material in the charge transfer complex if the semiconductor is a donor material.

2. A device according to claim 1, wherein the bond to the surface of the substrate is a chemical or electrostatic bond or a combination thereof.

3. A device according to claim 1, wherein the charge transfer material is an organic compound.

4. A device according to claim 1, wherein the organic compound comprises a functional group which forms the bond to the surface of the substrate.

5. A device according to claim 4, wherein the functional group is material selective and forms the bond to a specific substrate material.

6. A device according to claim 1, wherein the charge transfer material is provided at the surface of the substrate and the device further comprises a connection layer without charge transfer components provided between the surface of the substrate and the charge transfer material, wherein the connection layer forms a bond to the surface of the substrate and a bond to the charge transfer material.

7. A device according to claim 6, wherein the bonds of the connection layer each is a chemical or electrostatic bond or a combination thereof.

8. A device according to claim 6, wherein the connection layer is formed of an organic bonding agent.

10. A device according to claim 1, wherein the charge transfer material is an atomic or molecular inorganic compound.

11. A device according to claim 10, wherein the charge transfer inorganic compound is provided on the surface of the substrate and is formed of a material which reacts chemically with the substrate and which forms a connection layer consisting of a chemical compound of the substrate material and the inorganic compound between the substrate and the inorganic compound.

12. A device according to claim 10, wherein the charge transfer inorganic compound is provided at the surface of the substrate and the device further comprises a connection layer provided between the substrate and the inorganic compound, wherein the connection layer comprises

a chemical compound of the substrate material or a material with similar chemical properties, and the charge transfer inorganic compound.

13. A method for fabricating a device of claim 1 which comprises

providing a charge transfer material as a patterned or unpatterned self-assembling layer of one or more atomic or molecular layers on or at a surface of the substrate, wherein the charge transfer material includes charge transfer components in the form of donors and/or acceptors,

forming a direct or indirect bond between the charge transfer material and the surface of the substrate,

and forming a charge transfer complex of the charge transfer material together with a thereabove adjacently provided organic or inorganic semiconductor, wherein the charge transfer material forms a donor or acceptor material in the charge transfer complex depending upon respectively whether the semiconductor itself is an acceptor or donor material.

14. A method according to claim 13, which further comprises forming the bond as a chemical or electrostatic bond or a combination thereof.

15. A method according to claim 13, which further comprises selecting the charge transfer material as an organic compound.

16. A method according to claim 15, which further comprises selecting the organic compound with a functional group which forms the bond to the surface of the substrate.

17. A method according to claim 16, which further comprises selecting the functional group as a material-selective group such that the bond is formed to a specific substrate material.

18. A method according to claim 13, wherein the charge transfer material is provided at the surface of the substrate, and which further comprises providing a connection layer without charge transfer components between the surface of the substrate and the charge transfer material, and forming the connection layer with a bond to the surface of the substrate and with a bond to the charge transfer material.

19. A method according to claim 18, which further comprises forming each bond in the connection layer as a chemical or electrostatic bond or a combination thereof.

20. A method according to claim 18, which further comprises forming the connection layer of an organic bonding agent.

22. A method according to claim 13, which further comprises selecting the charge transfer material as an atomic or molecular inorganic compound.

23. A method according to claim 22, wherein the charge transfer inorganic compound is provided on the surface of the substrate, and which further comprises forming the inorganic compound of a material which reacts chemically with the substrate such that between the substrate and the inorganic compound a connection layer consisting of a chemical compound of the substrate material and the inorganic compound is formed.

24. A method according to claim 22, wherein the charge transfer inorganic compound is provided at the surface of the substrate, and which further comprises providing a

connection layer consisting of a compound of the substrate material or a material with similar chemical properties, and the inorganic compound, between the substrate and the inorganic compound.